Vegetation dynamical responses to multivariate extremes in the Western US

Charlie Koven, LBNL
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With many others: Junyan Ding (LBL), Polly Buotte (UCB), Lara Kueppers (LBL/UCB), Jackie Shuman (NCAR), Chonggang Xu (LANL), Ryan Knox (LBL), Greg Lemieux (LBL), Brad Christoffersen (UTRGV), Rosie Fisher (CERFACS), Zachary Robbins (LANL), Wu Ma (LANL), Alex Hall (UCLA), Michael Goulden (UCI), Jim Randerson (UCI), Yufang Jin (UCD), Rong FU (UCLA), Max Moritz (UCSB), Roger Bales (UCM)

ECRP Project: How to use recent California Drought as a testbed for climate-driven disturbance in the western US?
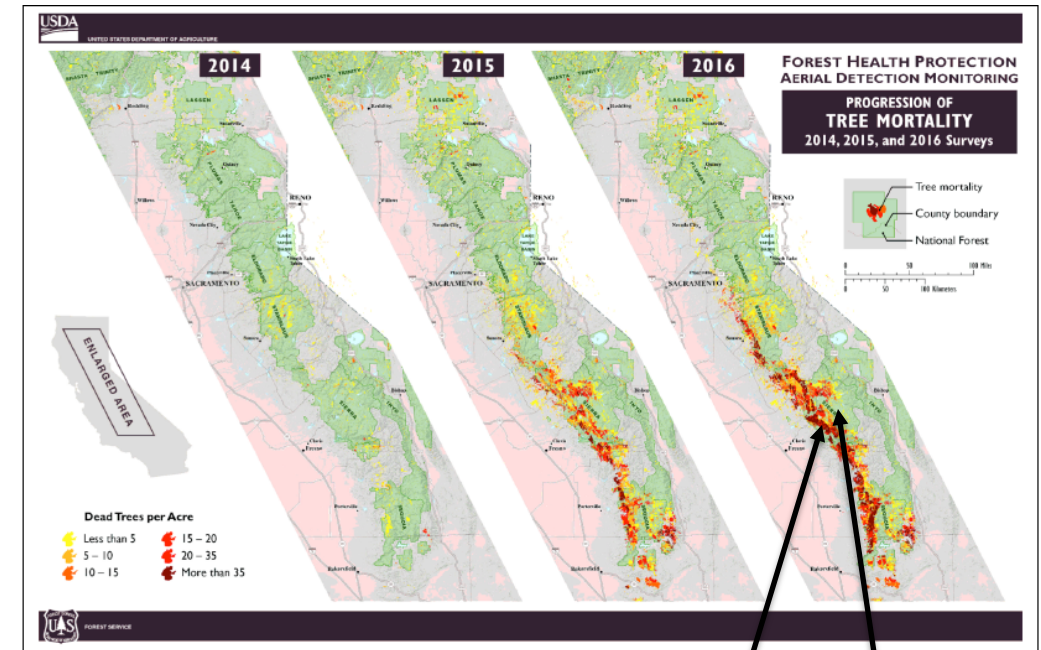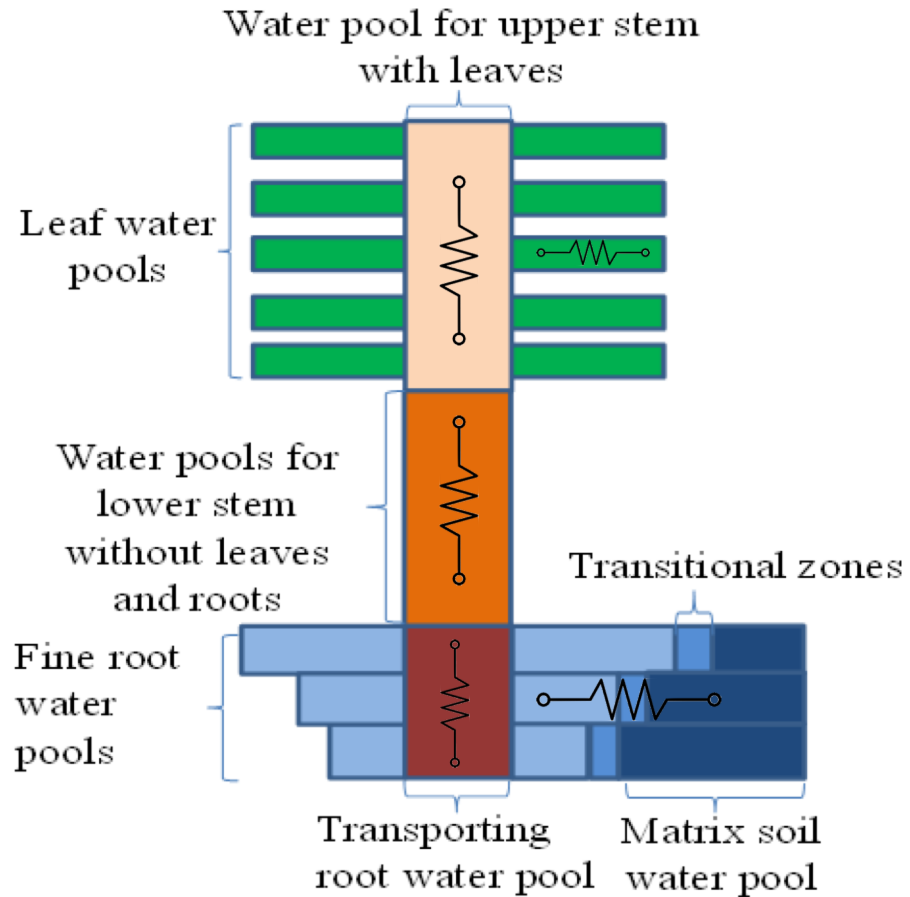
Eddy Covariance Sites: Southern Sierra CZO

USFS aerial forest mortality survey, 2016

US-CZ2 site
(1100m)

US-CZ3 site
(2000m)

US-CZ2

US-CZ3

Key tool: FATES-Hydro: Representing plant hydraulic traits in E3SM

Water pool for upper stem with leaves

Leaf water pools

Water pools for lower stem without leaves and roots

Transitional zones
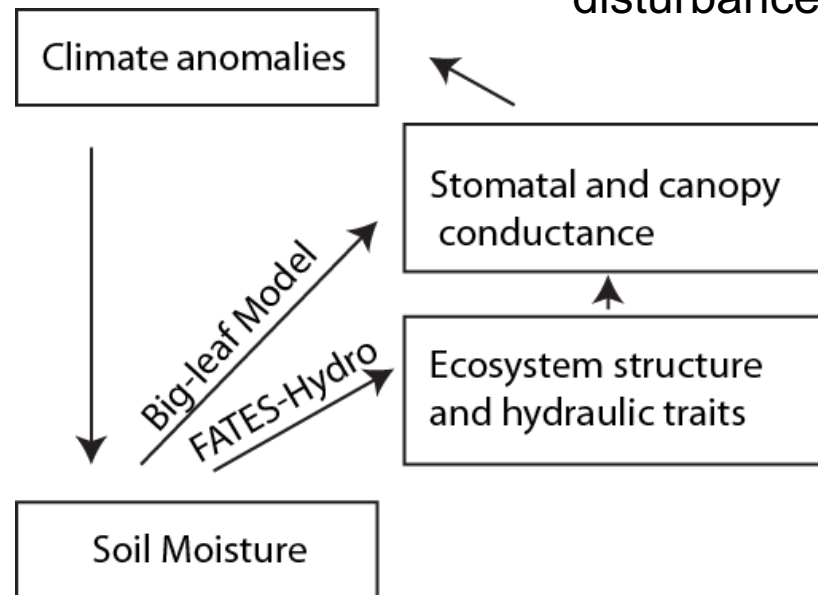
Fine root water pools

Transporting root water pool

Matrix soil water pool

Xu, Christoffersen et al., *in prep*
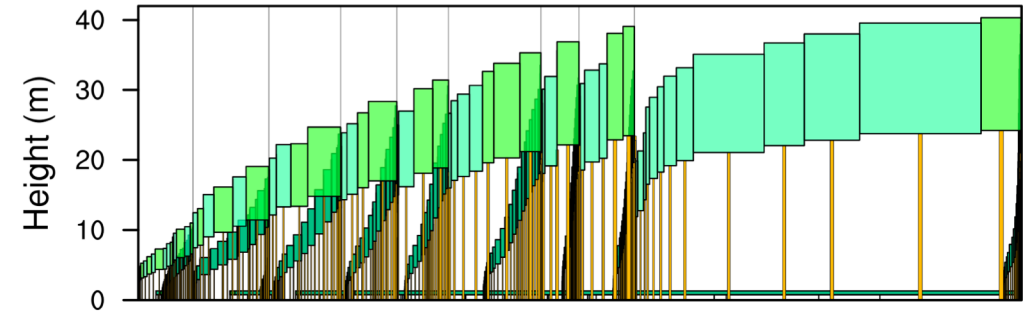
Youngest since disturbance

Oldest since disturbance

Koven et al., 2020

Climate anomalies

Stomatal and canopy conductance

Big-leaf Model

FATES-Hydro

Ecosystem structure and hydraulic traits

Soil Moisture

Shallow-rooted PFT
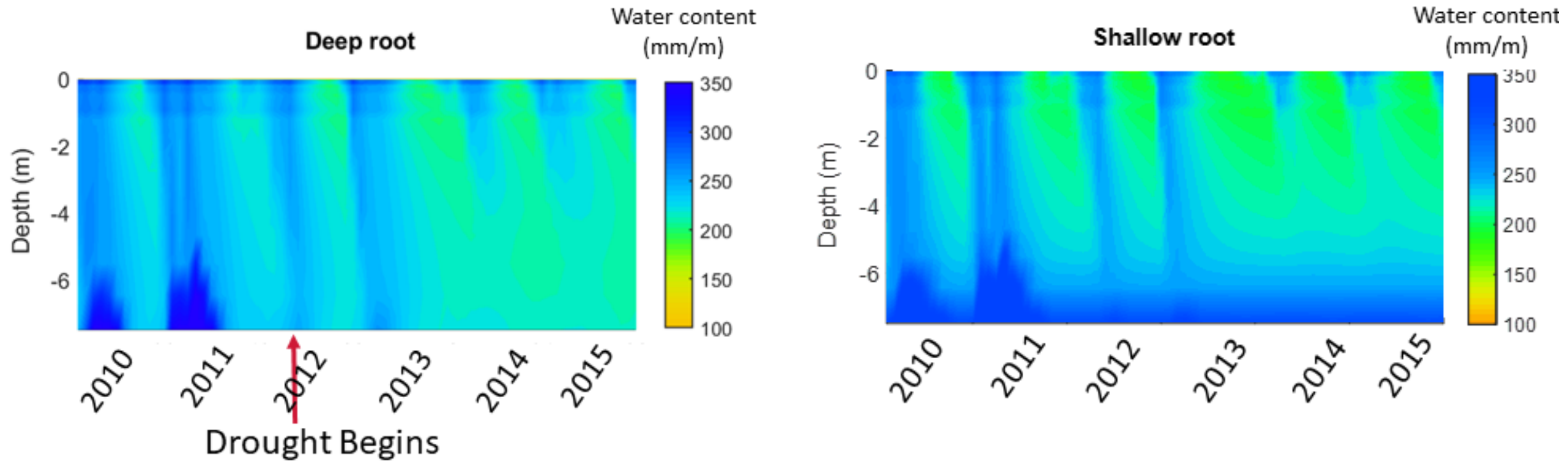Deep-rooted PFT

Drought Begins

Mass Tree Mortality

Results show tradeoff among plant hydraulic strategies: what works well during a normal year may create vulnerabilities during extreme events.
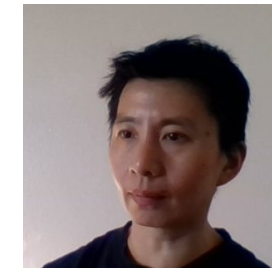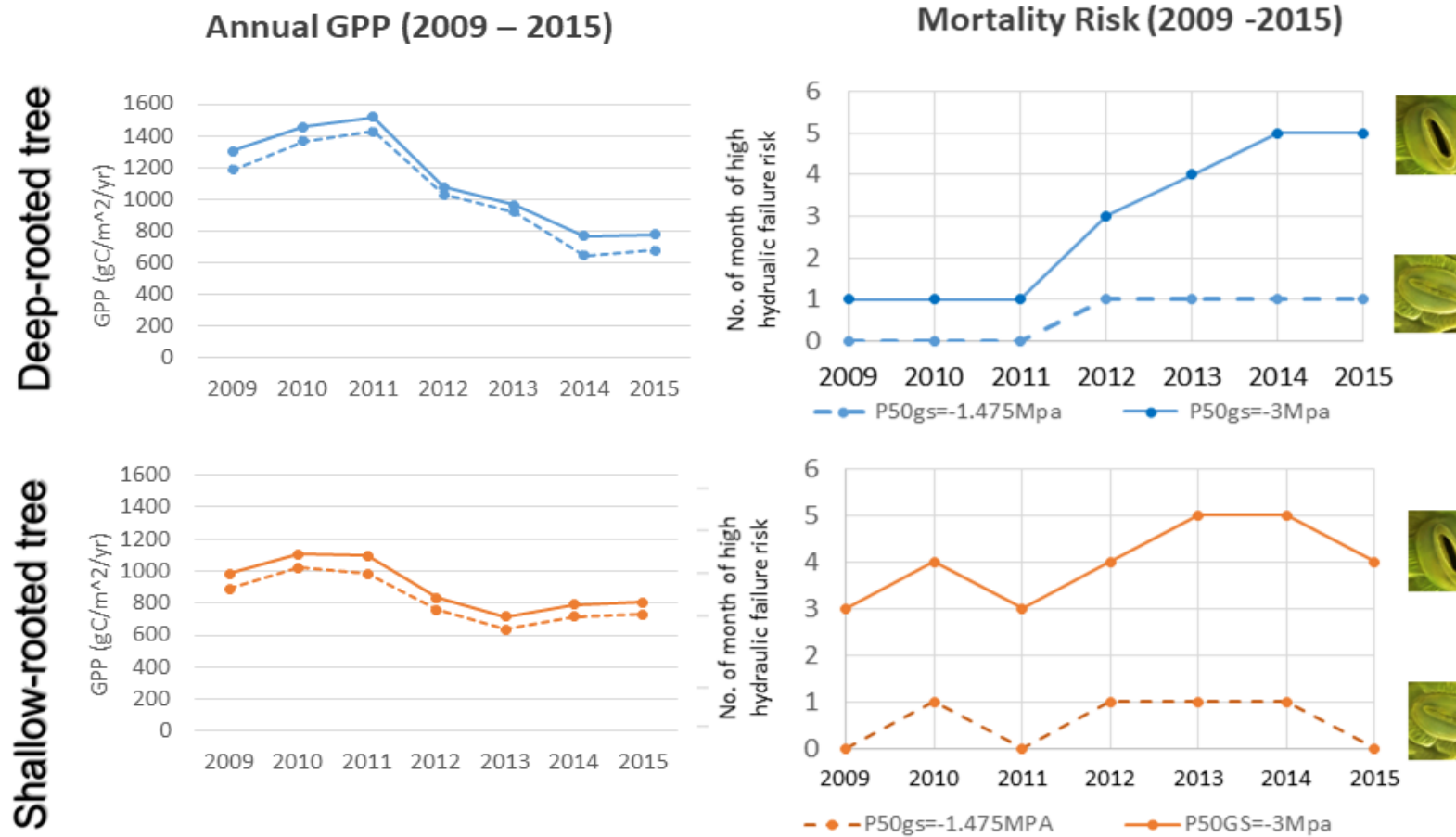
Junyan Ding et al., *in review*

Key role of deep soil water and its depletion during drought
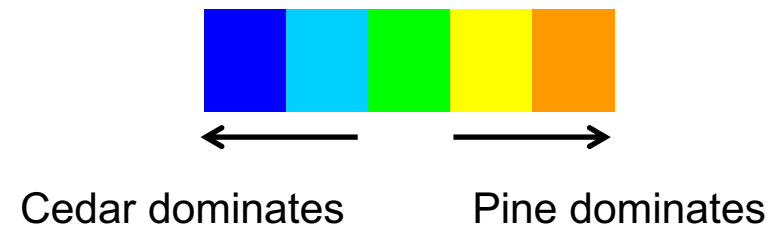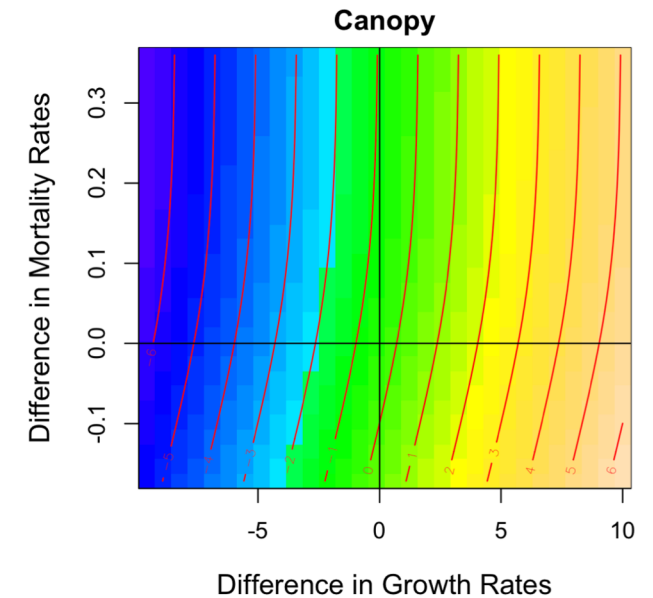

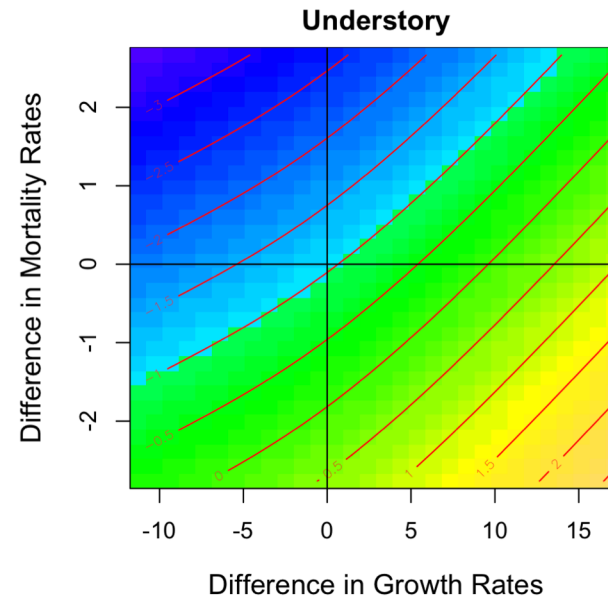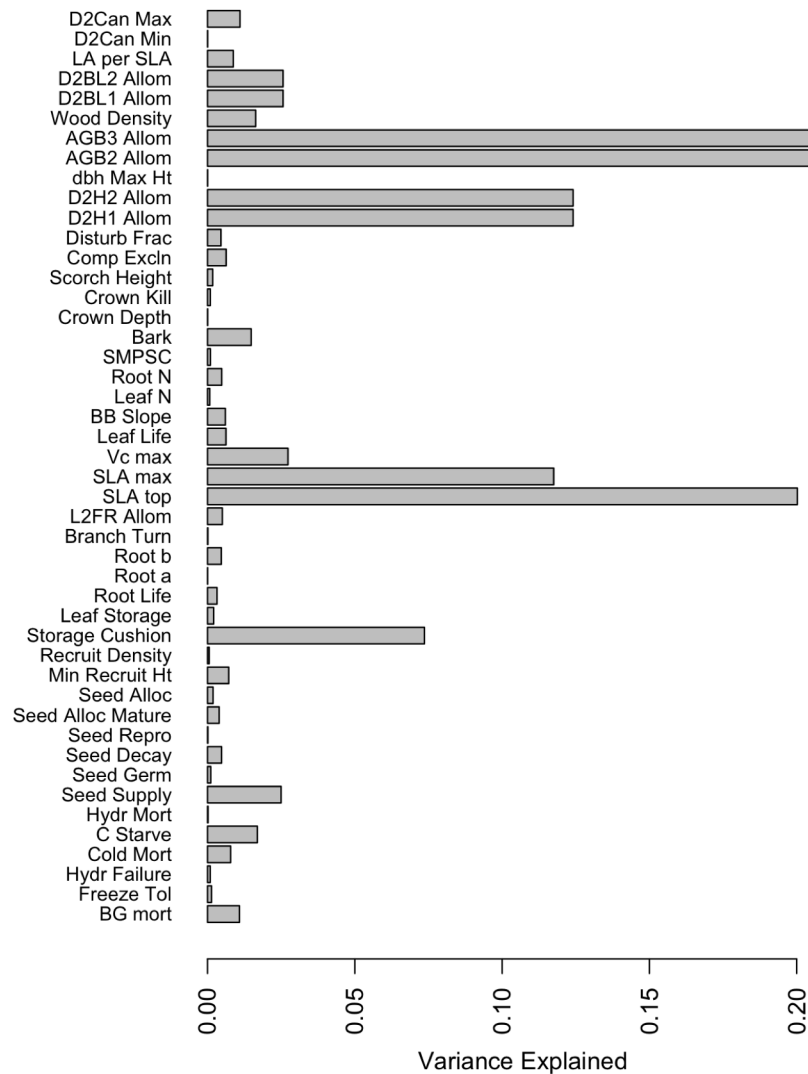Junyan Ding et al., *in review*

Interplay between root traits and leaf hydraulic traits create vulnerabilities during drought

Junyan Ding et al., *in review*

Scaling up in space and time: effects of trait values on tree coexistence in Sierra Nevada mixed conifer forests

Traits → Rates → Structure

Understory

Difference in Mortality Rates vs Difference in Growth Rates

Canopy

Difference in Mortality Rates vs Difference in Growth Rates

Cedar dominates ← → Pine dominates

Polly Buotte et al., *in prep*

Ongoing and next steps

- Scaling up simulations to cover full set of California climates

- Exploration of how specification of PFTs governs mean-state behavior of ecosystem structure, function, and disturbance regimes

- Focus on benchmarking other disturbance regimes, in particular fire, in collaboration with other projects: California Ecosystem Futures (UC Lab Fees), LDRD

- Historical transient simulations to attribute changes in forest structure and disturbance regime to different drivers

- Future transient simulations to explore sensitivity of dynamics to driving mechanisms, parameter uncertainty, and scenario divergences

- Coupling to E3SM to explore role of biophysical feedbacks in regional climate